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This is a brief report on some work done at Carnegie-Mellon University
on computer architecture certification and work on an operating system
for CM*, a multiple processor architecture.

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THE MEASUREMENT AND EVALUATION OF
ALTERNATIVE COMPUTER ARCHITECTURES

FINAL REPORT

AUTHOR: William B. Dietz

5 October 1979

U.S. ARMY RESEARCH OFFICE

GRANT NUMBER: DAAG29-77-G-0155

Carnegie-Mellon University
Computer Science Department
Pittsburgh, Pennsylvania

Table of Contents

1. Problem Studied

Two different problems in computer architecture were studied under this grant. The first involved exploring methods of measuring a new implementation of a computer architecture to determine the extent to which a new implementation conformed to the specified architecture. The second involves the on-going research in multiple processor computer architecutres at CMU.

1.1 Architecture Certification

Once a computer architecture has been specified, it should be possible to build a number of implementations of that architecture which will all run the same time-independent programs. The problem of determining whether or not the specification of the architecture is met in a particular implementation we call certification. When an implementation of a computer architecture is "certified", this means that the hardware has passed a number of tests designed to find errors in the implementation. Part of this grant was used to do preliminary work in defining what should be tested as part of an architecture certification procedure.

1.2 Multiple Processor Studies

The basic problem addressed by this research was one of finding suitable operating system structures for distributed architectures such as Cm*. A combination of distribution and sharing present in such arcitectures makes it unreasonable to use traditional operating system structures.

The goal of the research was to produce a multi-user time sharing system that would exploit several of the unique attributes of the Cm* hardware and provide information about what structures are suitable for distributed operating systems in general. The operating system, called Medusa, would have three key attributes:

Modularity: The system should consist of a large number of small, cooperating subcomponents that could be built, modified and measured separately. Such a structure would complement the Cm* hardware.

Robustness: The system should be able to respond in a reasonable way to changes in its environment. These changes include an increase or decrease in the workload and failures in hardware, firmware or software components.

Performance: Both the structure of the operating system and the abstractions it provides

should reflect rather than hide the underlying hardware. Application programs should be able to run with approximately the same efficiency under the operating system as on the bare hardware.

2. Results

2.1 Certification Results

The certification of a complex computer architecture is a difficult task to perform in a thorough manner. The work completed under this grant is insufficient to publish any meaningful results. Boundary conditions which should be explored by the tests were mapped out, but this covered only the arithmetic section of the architecture. Other methods of creating certification programs were explored which laid some ground work for methods we are currently exploring. One method which holds some promise is the generation of certification programs from a formal description of the architecture such as an ISP description. Some preliminary programs have been generated.

2.2 Multiple Architecture Results

The design and coding of the operating system are substantially complete, and most of the lowest layer (written in microcode) has been debugged. The next phase involves integration of the microcode and the Utilities that were written in BLISS.

We expect to have a partial system running by the end of August and a complete system by the end of September ot the middle of October.

3. Publications

Medusa: An Experiment in Distributed Operating System Structure.   John Ousterhout, Donald Scelza, Pradeep Sindhu. (This paper was accepted for this year's SOSP so it will be in the proceedings for that conference)

4. Participating Personal

4.1 Faculty/Staff

Leonard Shustek

William Dietz

Paul Shaman

4.2 Students

Pradeep Sindhu

Konrad Lai (Received Master's Degree while working under this grant)